COMBINED EFFECTS OF OAT BRAN SUPPLEMENTATION AND JOGGING EXERCISE ON BODY COMPOSITION, BLOOD LIPID PROFILES AND CARDIORESPIRATORY ENDURANCE IN FEMALE UNIVERSITY STUDENTS

By

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CERTIFICATE

This is to certify that the dissertation entitled

COMBINED EFFECTS OF OAT BRAN SUPPLEMENTATION AND JOGGING EXERCISE ON BODY COMPOSITION, BLOOD LIPID PROFILES AND CARDIORESPIRATORY ENDURANCE IN FEMALE UNIVERSITY STUDENTS

Is the bona fide record of research work done by

MUHAMMAD ALIF RIDZUAN BIN HAMZAH

During the period of OCTOBER 2014 to JUNE 2015
Under my supervisor

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Abstract

Introduction: It is known that beta-glucan in oat bran could reduce level of total cholesterol (TC), triglycerides (TG) and low density lipoprotein cholesterol (LDL-C) and increase high density lipoprotein (HDL-C). Meanwhile, aerobic exercise is known to be beneficial to improve body composition and increase maximum oxygen uptake (VO_{2max}). However, the additional combined effect of oat bran supplementation and aerobic exercise is still lacking.

Objective: To investigate the effectiveness of combined oat bran supplementation and jogging exercise compared to oat bran supplementation alone or jogging exercise alone on body composition, lipid profiles and cardiorespiratory endurance in female university students.

Methods: 48 female university students were randomly assigned to 4 groups: control (C), oat bran supplementation alone (Ob), Exercise alone (Ex) and combined oat bran and exercise (ObEx) groups. Pre- and post tests were carried out to measure participants' body anthropometry, body composition, blood lipid profiles and predicted VO_{2max}. During the intervention period, participants in Ob and ObEx groups consumed oat bran daily for 6 weeks. Participants in ObEx consumed oat bran 1 hour before jogging exercise on the exercise days. Participants in Ex and ObEx groups carried out jogging exercise 3 days per week for 6 weeks.

Results: There were no significant changes in percentage body fat and fat free mass in all groups. Statistically, significant reductions in TC (-13.57%), TG (-20.65%), LDL-C (-10.77%) and VO_{2max} (5.9%) were observed in ObEx group. In Ob group, there were significant reduction in TC (-11.42%) and LDL-C (-

9.16%). Similarly, significant reductions in TC (-9.43%) and LDL-C (-8.0%) were also observed in Ex group. ObEx group showed significant increase in VO_{2max} and the increase in VO_{2max} was the highest among all the groups.

Conclusion: Combination of oat bran supplementation and jogging exercise significantly reduced level of total cholesterol, triglyceride and low density lipoprotein cholesterol, however did not affect high density lipoprotein cholesterol level. This combination also improved participant's cardiorespiratory endurance. In general, the combination of oat bran and jogging exercise elicited more beneficial effects on blood lipid profiles and cardiorespiratory endurance compared to control, oat bran supplementation alone and exercise alone groups. Therefore, this combination can be recommended for improving lipid profiles and cardiovascular fitness in young female population.

Abstrak

Pengenalan: Adalah diketahui bahawa beta-glucan terkandung dalam oat bran boleh mengurangkan jumlah kolesterol (TC), trigliserid (TG) dan kolesterol lipoprotein ketumpatan rendah (LDL-C) dan meningkatkan kolesterol ketumpatan tinggi (HDL-C). Pada masa yang sama, adalah diketahui bahawa senaman aerobik dapat memberi kebaikan kepada komposisi badan dan meningkatkan pengambilan oksigen maksimum (VO_{2max}). Namun, kajian tentang kesan tambahan daripada kombinasi antara pengambilan oat bran dan senaman aerobik masih kurang.

Objektif: Menyiasat keberkesanan kombinasi pengambilan oat bran dan senaman joging berbanding dengan pengambilan oat bran sahaja atau senaman joging sahaja ke atas komposisi bandan, profil lipid darah dan ketahanan respiratori dalam kalangan pelajar perempuan universiti.

Kaedah: 48 pelajar perempuan daripada universiti dibahagikan kepada empat kumpulan secara rawak: kumpulan kawalan (C), kumpulan pengambilan oat bran sahaja (Ob), kumpulan melakukan senaman joging sahaja (Ex) dan kumpulan kombinasi pengambilan oat bran dan melakukan senaman (ObEx). Pra-ujian dan pasca-ujian telah dilakukan dengan mengukur antropometri badan, komposisi badan, profil lipid darah dan ramalan VO_{2max}. Dalam tempoh intervensi, peserta-peserta dalam kumpulan Ob dan ObEx mengambil suplemen oat bran setiap hari selama 6 minggu, dan peserta-peserta dalam kumpulan ObEx mengambil oat bran sejam sebelum melakukan senaman pada hari senaman. Peserta-peserta dalam kumpulan Ex dan ObEx melakukan senaman joging 3 kali seminggu selama 6 minggu.

Keputusan: Tiada perubahan dalam peratusan lemak badan dan jisim tanpa lemak dalam semua kumpulan. Penurunan TC (-13.57%), TG (-20.65%), LDL-C (-10.77%) dan penigkatan VO_{2max} (5.9%) dapat diperhatikan dalam kumpulan ObEx. Bagi kumpulan Ob, adanya penurunan ketara secara statistic bagi TC (-11.42%) dan LDL-C (-9.16%). Penurunan ketara secara statistik bagi TC (-9.43%) dan LDL-C (-8.0%) juga diperhatikan dalam kumpulan Ex. Kumpulan ObEX menunjukkan peningkatan yang ketara dalam VO_{2max} dan peningkatan VO_{2max} adalah yang paling tinggi antara kumpulan.

Kesimpulan: Kombinasi pengambilan oat bran dan senaman joging dapat mengurangkan tahap jumlah kolesterol, trigliserid dan LDL-C secara berkesan, tetapi ia tidak mempegaruhi HDL-C. Malah kombinasi tersebut juga meningkatkan kelasakan kardiorespiratori peserta-peserta. Secara umum, kombinasi oat bran dan joging mendatangkan kesan baik ke atas profil lipid dan kelasakan kardiorespiratori jika dibandingkan dengan kumpulan kawalan, kumpulan mengambil oat bran sahaja dan kumpulan melakukan senaman sahaja. Maka, kombinasi tersebut boleh dicadangkan untuk mendatangkan kesan baik ke atas profil lipid dan kecergasan kardiovaskular dalam populasi perempuan muda.

CHAPTER 1

INTRODUCTION

The present study investigated the combined effects of oat bran supplementation and jogging exercise on body composition, cardiorespiratory endurance and blood lipid profiles in female university students. In year 1997, the US Food and Drug Administration (FDA) has passed a rulling that allowed oat bran to be registered as the first cholesterol-reducing food at an amount of 3 grams beta glucan daily (US Food and Drug Administration, 1997). It is also known that exercise with moderate intensity can improve body composition by decreasing percentage of body fat and increasing lean body mass (Volaklis *et al.*, 2007; Wong *et al.*, 2008). Cardiorespiratory endurance of an individual indicates how long the ability of heart and lung to sustain a given physical demand (DeBruyne *et al*, 2011), and maximum oxygen consumption (VO_{2max}) of an individual can reflect one's cardiorespiratory endurance fitness level. It is recommended in 'American College of Sports Medicine/ACSM's Guidelines for Exercise Testing and Prescription' (2010) that exercise at moderate intensity of cardiovascular endurance/ aerobic activities can improve ones cardiorespiratory endurance (Ehrman, 2010). Meanwhile, Trejo-Gutierrez & Fletcher (2007) mentioned that regular exercise can decrease one's lipid profiles such as total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and triglycerides (TG), and increase high density lipoprotein cholesterol (HDL-C). Since to date, the information of the additional beneficial effects of combined oat bran and jogging exercise with moderate intensity compared to

oat bran supplementation alone or jogging exercise alone on body composition, cardiorespiratory endurance via predicted VO_{2max}, and blood lipid profiles in female university students are lacking, therefore the present study was proposed.

1.1 OBJECTIVE OF THE STUDY

The main objective of this study was to investigate the effectiveness of combined oat bran supplementation and jogging exercise compared to oat bran supplementation alone, jogging exercise alone or sedentary without oat supplementation on body composition, cardiorespiratory endurance, and lipid profiles in female university students.

1.2 SIGNIFICANCE OF THE STUDY

To date, the information of combined oat bran and jogging exercise on body composition, cardiorespiratory endurance and blood lipid profiles in female university students are lacking, therefore the present study was proposed. The findings of the present study can then be used for formulating guidelines in the field of nutrition and exercise and sports for improving body composition, cardiovascular fitness and maintain healthy level of blood lipid profiles in young females.

1.3 HYPOTHESIS

H_o: There are no significant differences between combined oat bran supplementation and jogging exercise (ObEx) compared to oat bran supplementation alone (Ob), jogging exercise alone (Ex) and control (C) groups in percentage of body fat and lean body mass, cardiorespiratory endurance and blood lipid profiles, i.e. total cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C).

H_A: There are significant differences between combined oat bran supplementation and jogging exercise (ObEx) compared to oat bran supplementation alone (Ob), jogging exercise alone (Ex) and control (C) groups in percentage of body fat and lean body mass, cardiorespiratory endurance and blood lipid profiles, i.e. total cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C).

1.4 OPERATIONAL DEFINITIONS

Jogging exercise program: Jogging exercise program with 30 minutes per session, 3 times per week for 6 weeks, performed by participants in exercise alone (Ex) and combined oat bran and exercise (ObEx) groups.

Oat bran powder supplementation: Product of Biogrow Company, i.e. oat bran powder BG22, consumed by participants in oat bran supplementation alone (Ob) and combined oat bran supplementation and exercise (ObEx) groups, with dosage of 2 scoops (18 gram) with 3.6gram of beta glucan every day for 6 weeks.

Body composition: Measurement of percentage of body fat and fat free mass.

Cardiorespiratory endurance: Cardiorespiratory endurance of the participants determined via predicted maximum oxygen volume consumption (VO_{2max}) by performing 20-meters shuttle run test.

Blood Lipid profiles: Measurement of blood parameters, i.e. total cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C).

Female university students: A group of Malaysian university females between 19-25 years old.

CHAPTER 2

LITERATURE REVIEW

2.1 BLOOD LIPID PROFILES COMPONENTS

Components of blood lipid profile include total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C). LDL-C contain 25% proteins, 5% triglycerides, 20% phospholipids, and 50% cholesterol. LDL-C deposit in and around smooth muscle fibers in arteries. When LDL-C present in excessive numbers, it can form fatty plaques that increase the risk of coronary artery disease. It is also known as bad cholesterol (Tontora & Derrickson, 2011).

HDL-C which contain 40-45% proteins, 5-10% triglycerides, 30% phospholipids, and 20% cholesterol, can remove excess cholesterol from blood cells, and transport it to liver for elimination. It can prevent accumulation of the fatty plaques. High level of HDL-C is associated with decreased risk of coronary artery disease and known as good cholesterol (Tontora & Derrickson, 2011).

2.2 BETA-GLUCAN CHOLESTEROL-LOWERING AGENT

In year 1997, The US Food and Drug Administration (FDA), which assesses health claims for foods, has approved health claims for the viscous fibers oat β-glucan as cholesterol-lowering agent, and it can reduce the risk of cardiovascular disease. Additionally, the FDA has passed a rulling that allowed oat bran to be registered as the first cholesterol-reducing food at an amount of 3 grams beta-glucan daily (US Food and Drug Administration, 1997).

In year 2010, the Panel on Dietetic Products, Nutrition and Allergies of the European Food Safety Authority also had issued an opinion that there is a scientific substantiation of a health claim related to oat beta-glucan and lowering of blood LDL and total cholesterol. They mentioned that lowering blood LDL-cholesterol concentrations is a beneficial physiological effect by decreasing the risk of coronary heart disease. The effect of oat beta-glucan at doses of at least 3 grams per day have shown a decrease in LDL-cholesterol concentrations. The Panel also mentioned that a cause and effect relationship has been established between the consumption of oat beta-glucan and lowering of blood LDL-cholesterol concentrations. The Panel also considered that foods should provide at least 3 g of oat beta-glucan per day. This amount can reasonably be consumed as part of a balanced diet in adults who want to lower their blood cholesterol concentrations (European Food Safety Authority, 2010)

2.3 OAT BRAN AND BLOOD LIPID PROFILES

To date, it is known that one of the cholesterol reduction supplement is Biogrow Oat BG22™ oat bran powder with 20% of beta glucan. It contains carbohydrate, dietary fiber, protein, fat, magnesium, iron, zinc and sodium. The recommended doses for an individual is 2 scoops (18 gram) per day, which can provide 3.6 gram of beta glucan (Biogrow Compony, 2014).

Oat bran is a part of oat, and *Avena sativa* is the scientific name. When the oats arrive from the farm, one of the first jobs after cleaning is to remove the outer husk of the oat. The part of the oat left after this 'shelling' process is the 'groat'. The outer layer of the groat contains bran. The groat with bran is called oat bran. Oat bran consists of beta glucan which can reduce low-density lipoprotein cholesterol (LDL-C) (Biorklur *et al.*, 2005; Queenan *et al.*, 2007). Wolever *et al.* (2010) reported that consumption of a minimum of 3 gram high molecular weight oat beta glucan per day can reduce cardiovascular disease (CVD) risk by up to 12%. They also reported that consumption of at least 2 servings of oat beta-glucan per day for 4 weeks demonstrated a 5.5% average decrease in LDL-C level. This is beneficial for human health since 1% reduction in LDL-C reduces CVD risk by 2%.

2.4 EXERCISE, BODY COMPOSITION, CARDIORESPIRATORY ENDURANCE AND BLOOD LIPID PROFILES

According to American College of Sports Medicine/ACSM's guidelines for exercise testing and prescription (2010), exercises can be divided into three main types, i.e. aerobic or cardiovascular endurance exercise, resistance exercise for muscular fitness and flexibility exercise. The recommended components of an exercise training session are such as warm-up at least 5-10 minutes with low to moderate intensity activities, followed by 20 to 60 minutes of conditioning activities, and at least 5-10 minutes with low to moderate intensity activities as cool-down. The exercise recommendation framework for frequency, intensity, time of exercise and type of exercise (FITT) for sedentary healthy adults are 3 to 5 days per week, 57% to 67% of heart rate maximum (HRmax), 20 to 30 minutes per day/60 to 150 min per week, with walking, jogging, stepping and cycling exercise (Ehrmen, 2010).

Body composition includes body fat and lean (fat free) body mass. It is known that exercise with moderate intensity can improve body composition by decreasing percentage of body fat and increasing lean body mass (Volaklis et al., 2007; Wong et al., 2008). Cardiorespiratory endurance of an individual indicates how long the ability of heart and lung to sustain a given physical demand (DeBruyne et al, 2011), and maximum oxygen consumption (VO_{2max}) of an individual can reflect one's cardiorespiratory endurance fitness level.

It was recommended in 'American College of Sports Medicine/ACSM's Guidelines for Exercise Testing and Prescription' (2010) that exercise at moderate intensity of cardiovascular endurance/ aerobic activities can improve one's cardiorespiratory endurance (Ehrman, 2010). Meanwhile, Trejo-Gutierrez & Flercher (2007) mentioned that regular exercise can decrease one's lipid profiles such as total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and triglycerides (TG), and increase high density lipoprotein cholesterol (HDL-C). Several previous studies also have shown evidences that exercise can elicit positive effects on lipid profiles (Kim et al., 2007; Marques et al, 2009; Coen et al, 2009).

Since to date, the information of the additional beneficial effects of combined oat bran and jogging exercise compared to oat bran supplementation alone or jogging exercise alone on body composition, cardiorespiratory endurance via predicted VO_{2max}, and blood lipid profiles in female university students are lacking, therefore the present study was proposed.

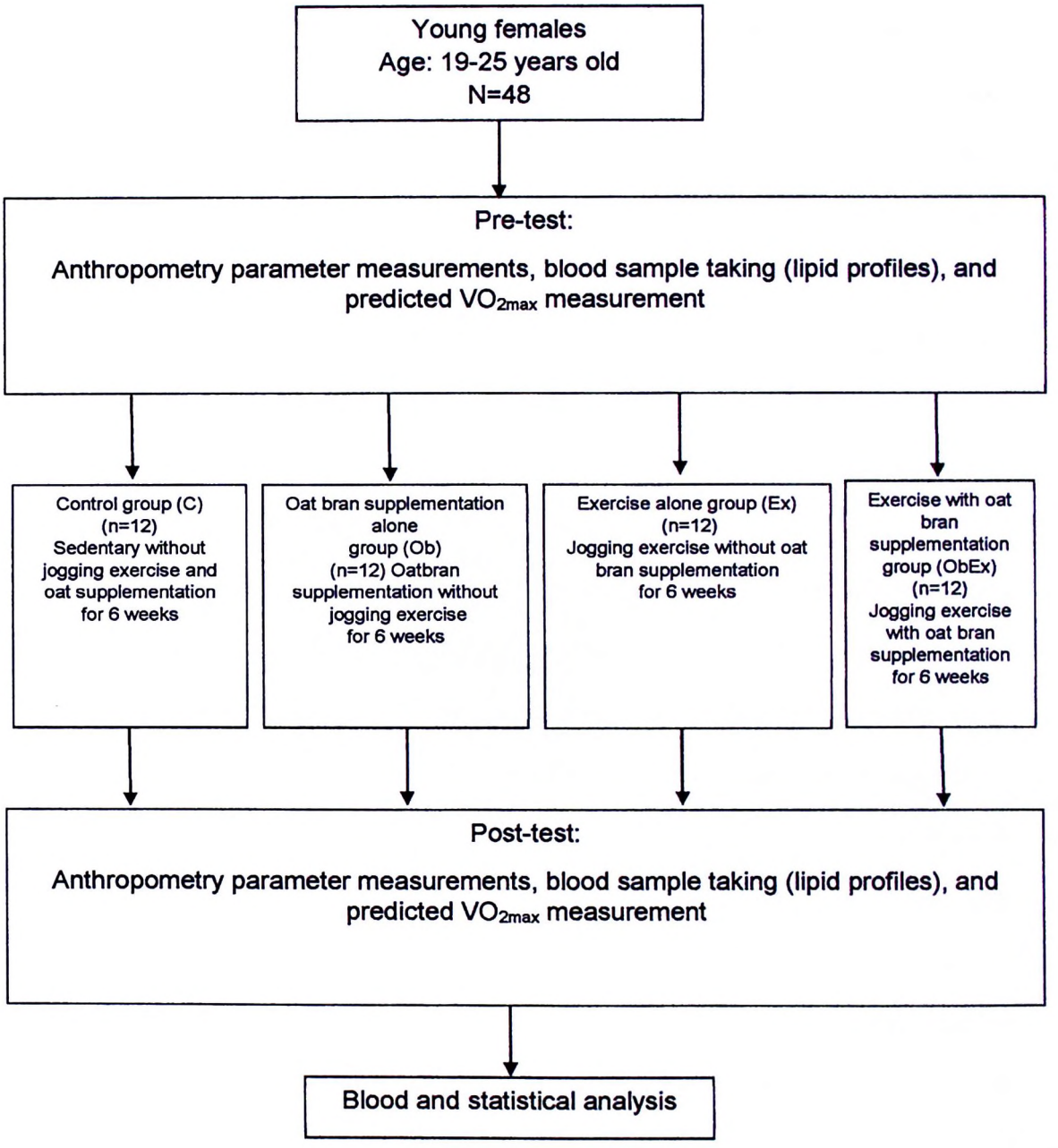
CHAPTER 3

MATERIALS AND METHODS

3.1 PARTICIPANTS

In this study, the inclusion criteria of participants were healthy volunteers who were free from any healthy problem, non-smokers, young females university student with age between 19-25 years old, did not engage with any training program or did not exercise more than once per week, and also did not have the habit of consuming oat bran. The participants were divided randomly into four groups, i.e. control group (C), oat bran supplementation alone group (Ob), exercise alone group (Ex) and combined oat supplementation with exercise group (ObEx). The whole experimental period was 6 weeks. Pre- and post test were performed before and after 6 weeks of experimental period (Figure 1).

Figure 1: Flow chart of the experimental design



3.2 EXPERIMENTAL DESIGN

3.2.1 Anthropometric characteristic, body composition and resting heart rate measurements

In this study, anthropometric parameters such as body height, body weight and body composition (percentage of body fat and lean body mass) were measured during pre- and post tests. A stadiometer (Seca 220, Germany) was used to measure the body height. Body composition and body weight were measured by using Tanita Body Composition Analyzer (model TBF-410). Participants' resting heart rate were taken immediately after woke up from sleep in the morning by themselves.

3.2.2 Blood lipid profiles measurement

Approximately 5 ml of resting venous blood sample was collected during each sample collection (pre- and post tests). Participants were asked to fast overnight from 12 a.m. (mid night) before fasting blood sample taking in the morning (8 a.m.). Then, blood samples were stored and analyzed for serum total cholesterol (TC), serum total triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). The procedures were handled by Sport Science Laboratory technologists of U.S.M. For blood analysis, Cholesterol CHOP-PAP method was used to analyze TC concentration. TG was determined with glycerol phosphate oxidase followed by a POD catalyzed indicator reaction, and HDL-C was determined after LDL-C was precipated by phosphotungstic acid with the presence of magnesium ion.

3.2.3 Cardiorespiratory endurance measurement

The cardiorespiratory endurance fitness level of the participants were determined via predicted maximum oxygen consumption (VO_{2max}) by performing a 20-meters shuttle run test. The tests were carried out before and after the experimental period. This test required the participants to run 20m in time with a "beep" sound from a CD recorder. Procedure of the test began with the participants warmed up for 10 minute. Prior to this, the researcher measured out a 20 meters section and marked each end with marker cones. Then, the researcher started the CD and the participants commenced the test. If the participants arrived at the end of a shuttle before the "beep" sound, the participants must wait for the "beep" sound to be heard and then resumed running. The participants must be placed one foot on or beyond the 20m marker at the end of each shuttle. If the participants failed to reach the end of the shuttle before the "beep" sound, they were allowed 2 or 3 further shuttles to attempt to regain the required pace before being withdrawn. At the end of the test, the researcher recorded the level and number of shuttles completed by the participants when they were withdrawn. The level and number of shuttles completed were then used for calculating the value of predicted VO_{2max} online (http://www.topendsports.com/testing/beepcalc.htm).

3.2.4 Oat supplementation

The participants in both oat bran supplementation alone (Ob) and exercise with oat bran supplementation group (ObEx) groups consumed oat bran supplementation with 2 scoops of Oat bran powder BG22™, i.e. 18 g of oat bran powder containing 3.6 grams of beta glucan, diluted with plain water every day for 6 weeks. The participants were required to consume 1 scoopful of Oat bran powder which was mixed with 250 ml of water before breakfast, and another 1 scoopful of Oat bran powder which was mixed with 250 ml of water before lunch or dinner. On the exercised days, the participants in ObEx group were required to consume oat bran one hour before jogging.

3.2.5 Jogging exercise program

Participants in the exercise without oat supplementation group (Ex alone) and exercise with oat supplementation group (ObEx) were required to follow jogging exercise program for 6 weeks. In the 6 weeks of exercise period, the participants were required to jog 3 times per week in the evening. Five minutes of warming up activities were carried out before 30 minutes of jogging exercise, after performing 30 minutes of jogging exercise, 5 minutes of cooling down activities were carried out. The exercise program was carried out under the supervision of the researcher in Health Campus of Universiti Sains Malaysia.

3.2.6 Calculation of sample size

Sample size used in this study was calculated by using PS Power and Sample Size Calculation version 3.0.43. Base on a study which was carried out by Kim et al. (2007), the power of study was set at 80% with 95% confident interval. The standard deviation (SD) observed was 15 mg/dl of high-density lipoprotein cholesterol (HDL-C). Difference in population mean was set at 19 mg/dl of high-density lipoprotein cholesterol (HDL-C). Calculated sample size was 11 participants per group. Estimated dropout rate during the experimental period is 10%, i.e. 1 participant per group. Therefore, we recruited 12 participants per group. Four groups of participants were recruited. Thus, the total number of participants in the present study were 48 participants.

3.2.7 Statistical analysis

Data was analyzed using the statistical software in the Statistical Package for Social Science (SPSS) Version 21.0. All data was expressed as means and standard deviation (±SD). Repeated measure ANOVA was performed to determine the significance of the difference between and within groups. Statistical significance was accepted at $p < 0.05$.

CHAPTER 4

RESULTS

4.1 ANTHROPOMETRIC CHARACTERISTIC AND BODY COMPOSITION

Forty eight participants with mean age of 20 ± 1.3 years old completed this study. The mean body height of the participants in C, Ob, Ex and ObEx was 156.5 ± 6.11, 156.83 ± 5.84, 153.75 ± 4.07 and 153.83 ± 6.49 respectively. The study results of body weight, percentage of body fat and fat free mass are illustrated in **Table 4.1**. In the pre- and post tests, there were no significant differences in body weight, percentage of body fat and fat free mass among all the groups. Similarly, there were no significant differences in these parameters between pre- and post tests in all the groups.

Table 4.1: Mean body weight, percentage of body fat and free fat mass (FFM) at pre- and post tests

Groups (N=48)	Body weight (kg) (Mean±SD)		Percentage of body fat (%) (Mean±SD)		Free fat mass (kg)	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Control (C) (n=12)	48.39 ±6.43	48.51 ±6.48	23.86 ±5.45	27.02 ±7.82	36.65 ±3.83	35.12 ±4.01
Oat bran (Ob) (n=12)	58.85 ±12.11	58.99 ±12.34	32.83 ±6.63	33.10 ±7.24	38.98 ±5.38	38.38 ±4.44
Exercise (Ex) (n=12)	52.50 ±7.49	52.73 ±7.49	29.55 ±5.89	31.44 ±7.05	36.67 ±3.22	35.72 ±2.64
Oat bran & Exercise (ObEx) (n=12)	49.75 ±5.60	49.75 ±5.33	27.97 ±5.16	27.16 ±5.86	35.70 ±3.32	36.03 ±2.53

4.2 BLOOD LIPID PROFILES

4.2.1 Total cholesterol (TC) concentrations

The total cholesterol concentration of each group are presented in **Table 4.2.1**. In pre- and post test, there were no significant differences among all the groups. After 6 weeks of study period, the concentration of total cholesterol significantly reduced in all the groups ($p<0.05$). However, combined oat bran & exercise group (ObEx) showed the highest percentage of reduction,–(-13.57%) followed by oat bran group, (-11.42%), exercise group (-9.43%) and control group, (-8.88%).

Table 4.2.1: Mean total cholesterol concentration at pre- and post tests

Groups (N=48)	Total cholesterol (mmol/L) (Mean±SD)			Mean percent difference (%)
	Pre-test	Post-test	Mean difference between pre and post	
Control (C)	4.92±0.91	4.40±0.78*	-0.52±0.81	-8.88
Oat bran (Ob)	4.98±0.32	4.42±0.56*	-0.57±0.45	-11.42
Exercise (Ex)	4.94±0.76	4.46±0.74*	-0.48±0.55	-9.43
Oat bran & Exercise (ObEx)	4.64±0.62	4.03±0.87*	-0.61±0.46	-13.57

*significantly different from pre-test ($p<0.05$)

4.2.2 Triglycerides (TG) concentrations

The mean triglycerides concentration of all groups are shown in **Table 4.2.2**. In pre- and post tests, there were no significantly differences of triglycerides concentrations among all the group. Combined oat bran and exercise group (ObEx) showed a significant reduction effect ($p<0.05$) after 6 weeks of study period compared to pre test, with decrement of 20.65%. However, there were no significant differences in triglycerides between pre- and post test in C, Ob and Ex groups.

Table 4.2.2: Mean triglycerides concentration at pre- and post tests

Groups (N=48)	Triglycerides (mmol/L) (Mean±SD)			Mean percent difference (%)
	Pre-test	Post-test	Mean difference between pre and post	
Control (C)	0.84±0.41	0.71±0.22	-0.13±0.36	-8.39
Oat bran (Ob)	0.89±0.31	0.83±0.27	-0.06±0.33	0.27
Exercise (Ex)	0.87±0.31	0.77±0.30	-0.10±0.43	-1.60
Oat bran & Exercise (ObEx)	0.83±0.26	0.63±0.16*	-0.20±0.17	-20.65

*significantly different from pre-test ($p<0.05$)

4.2.3 Low density lipoprotein cholesterol (LDL-C) concentrations

Mean LDL-C concentrations at pre- and post tests are presented in **Table 4.2.3**. At pre-and post tests, the values of LDL-C were not significantly different among all the groups. In Ob, Ex, and ObEx groups, there were significant reduction effect ($p<0.05$) in LDL-C in post test compared to pre test. Nevertheless, the mean percentage reduction in combined oat bran and exercise group (ObEx) was the highest (-10.77%), followed by oat bran group (-9.16%), exercise group (-8.00%) and control group (-6.11%).

Table 4.2.3: Mean low density lipoprotein cholesterol concentration at pre- and post tests

Groups (N=48)	Low density lipoprotein cholesterol (mmol/L) (Mean±SD)			Mean percent difference (%)
	Pre-test	Post-test	Mean difference between pre and post	
Control (C)	2.80±0.73	2.55±0.60	-0.25±0.53	-6.11
Oat bran (Ob)	2.87±0.36	2.62±0.47*	-0.25±0.22	-9.16
Exercise (Ex)	2.81±0.76	2.56±0.67*	-0.25±0.38	-8.00
Oat bran & Exercise (ObEx)	2.55±0.60	2.31±0.81*	-0.24±0.31	-10.77

*significantly different from pre-test ($p<0.05$)